

C.1 BACKGROUND

Recent history has shown significant technology advancements in the development of hypersonic flight systems. Current facilities within the United States (U.S.) High Speed/Hypersonic (HS/H) ground test infrastructure do not have the ability to generate the data necessary to execute low risk Test and Evaluation (T&E) programs. Improved T&E capabilities are needed to enhance data quality, information output, and test productivity of current and future HS/H ground T&E facilities. The ability to continuously change the simulated flight conditions in a relevant flight environment, while maintaining high quality flow characteristics on the ground over mission duration time scales, will provide a significant advantage over the current state-of-the-art facilities and reduce programmatic risk and uncertainty when transitioning to flight test programs.

Moving forward, three advancements will provide the greatest impact on enhancing existing test capabilities; specifically, the ability to supply clean air at hypersonic flight enthalpies, continuously vary Mach number within a single test at appropriate scales, and execute the test process over mission length durations.

The maturity of the technologies required to close these T&E gaps have been addressed at the individual component level and through a pilot scale facility (called Hypersonic Aero Propulsion Clean-Air Testbed (HAPCAT) in Ronkonkoma, New York (NY)) and by previous Science and Technology (S&T) projects. However, no program currently exists to integrate all aspects of the capability at the scale needed for large T&E efforts. This large scale integration effort will occur at the J5 Rocket Test facility located at AEDC and is addressed within this acquisition.

The Alumina (AL) Regenerative Storage Heater (RSH) System (Block 1 of this TO) technologies have progressed to a Technology Readiness Level (TRL) sufficient for demonstration in the operational environment. Current efforts are underway at HAPCAT to complete the demonstration of technology capabilities for the Variable Mach-Number Nozzle (VMN) and Yttria Stabilized Zirconia (YsZ) Regenerative Storage Heater (RSH) capabilities (Blocks 2 and 3 of this TO) and advance these to TRL 6 plus (+). The advancements of these technologies will reduce risks for future, larger scale facilities such as Project Phoenix.

C.2 SCOPE

The scope of this TO provides design, development, engineering and integration, testing, and system checkout of all system components and subsystems of the Phoenix test apparatus. The scope includes final demonstration of the integrated test capability to ensure the capability meets the overall operational metrics defined in the TO.

The Project Phoenix test capability will be sited at the AEDC, Arnold AFB, TN and integrated into an existing (mothballed) test facility asset, J5 Rocket Test Facility.

C.3 COMPONENT DESCRIPTIONS

The following descriptions provide background and summary of the component capabilities required under this TO. When fully integrated, these components provide the complete operational test capability for Hypersonic ground T&E. To date, the Government has defined all requirements associated with the described capabilities and has served as the primary integrator

for the systems described herein. Moving forward, utilizing the defined requirements, the contractor shall assume the role of primary system integrator with oversight support provided by the Government.

C.3.1 HIGH PRESSURE AIR (HPA) SYSTEM

The ability to test a hypersonic system, on the ground, at extended durations representative of flight mission profiles, is a significant advancement over state-of-the-art ground test facilities. Based on the inspection of mission runtimes of historical and planned future hypersonic systems, mission durations are, and will continue to be, significantly longer than what is currently possible in existing facilities. Furthermore, flight test failure analyses in recent hypersonic air breathing and boost-glide vehicles have reported ground test runtimes available have not adequately allowed the system performance and operability to be fully explored before flight. In order to accomplish mission representative test durations, large quantities of High Pressure Air (HPA) are necessary requiring an upgrade to the existing AEDC HPA infrastructure. The existing AEDC HPA distribution network will be available for integration in its current state and in working order. This includes the existing storage volume of 22 kft³, located in close proximity to Aerodynamic and Propulsion Test Unit (APTU), and the compressor systems required for storage volume charging to the current pressurization limit of 3,800 Pounds per Square Inch (PSI). It is estimated that approximately 27 kft³ additional storage capacity will be required to meet design test facility runtimes.

C.3.2 AL RSH SYSTEM

Development and characterization of HS/H propulsion systems, including advanced combined cycle, ducted-rocket, ramjet, boost-glide, and scramjet systems requires ground test facilities that simulate flight representative test conditions from Mach 3.5 to 7.5. Clean, non-vitiated air delivered to the test article at representative stagnation pressures and temperatures encountered in atmospheric flight is not currently available for hypersonic system development. A clean-air hypersonic test facility is necessary to provide a test medium having the chemical composition that will be encountered during atmospheric flight.

AL storage heaters will be utilized to heat HPA to 3,500 degrees R (°R) to achieve Mach 6 representative air temperatures for hypersonic ground T&E. AL cored brick heaters have been used for various applications across many industries, perhaps most notably at the Ramjet Test facility (RTF) at the National Aerospace Laboratory (NAL) Kakuda Research Center in Kakuda, Japan. The Kakuda RTF utilizes a RSH to heat HPA up to 2,600 degrees Fahrenheit (°F) (3,100°R) with a matrix of AL cored bricks as the heat storage media. Existing designs have supported the advancement for use in the Project Phoenix Facility, which includes additional refractory courses inside the RSH vessel, to achieve the thermal storage capacities required to meet Project Phoenix operational requirements.

The AL RSH system (also referred to as the AL storage heater) will provide the necessary heat addition to achieve the clean-air Mach 6 capability associated with the completion of Block 1 of this TO. To satisfy the heat storage requirements for this test capability, two AL storage heaters and associated components and subsystems will be required.

C.3.3 AIR DELIVERY SYSTEM (ADS)

Distribution of the generated energy to the system under test presents its own unique aerothermal challenges and considerations. It is critical that the distribution network, also known as ADS, should not interfere and negate the capital investment utilized to generate the extreme temperatures necessary to satisfy desired test conditions. The ADS refers to the hardware connecting the heater outlet to the facility nozzle inlet. This hardware will combine the flow streams from the two AL storage heaters, ambient HPA and two future YsZ Heaters into a well-mixed uniform flow stream. This system also includes the downstream heater isolation valves that serve a primary function during the blowdown operation as well as provide backflow protection to the heaters. The HAPCAT project ADS development process has provided valuable design influence for the large scale version of the components that will support Project Phoenix.

C.3.4 TEST FACILITY AND TEST ARTICLE

Testing hypersonic systems requires many of the same test facility and test article services found in traditional subsonic and supersonic system test campaigns. Test articles may require fuel for operation, shop air or nitrogen for instrumentation purge and support systems, and accommodations for user ignition system interfaces, among others. Likewise, facility systems identified to achieve the operational capability will require electric, nitrogen, oxygen, natural gas, and water services. Finally, controllability of the systems and the ability to measure and record information for both facility operations and the test article is an important aspect of the capability development.

The test facility services include all aspects of making Project Phoenix an operational test asset. This includes facility and test article controls, facility and test article instrumentation and data acquisition, shop air, nitrogen, electric, natural gas, water (high, medium, and low pressure), oxygen, test article fuel, test article ignition, test facility and test cell fire suppression, and test facility security systems.

C.3.5 MODEL INJECTION SYSTEM/FORCE MEASUREMENT SYSTEM (MIS/FMS)

An integrated MIS/FMS is being incorporated into the existing J5 test facility as part of Project Phoenix. The MIS will be capable of supporting a cruise missile scale hypersonic test article (3X) system in a freejet configuration over a Mach number range from 3.5 to 7.5 while providing the ability to vary Angle of Attack and/or Angle of Sideslip within a single run. This will aid the capability for systems under test to perform flight representative trajectory simulations on the ground prior to flight as well as provide protection to flight weight test articles during facility startup and shutdown operations.

As part of the development ¹of the MIS/FMS design, a detailed load analysis was completed to determine the thrust stand load characteristics and test article unstart load scenarios. This analysis was based on the test article and facility scale requirements. The load case analysis utilized AEDC Computational Fluid Dynamics (CFD) Loci-Chem software as the primary analysis tool, but also leveraged existing assessments completed for the APTU and the Von Kármán Facility (VKF) Tunnel.

¹ 1X refers to hypersonic system mass capture rates ~10 lbm/s

3X refers to hypersonic systems with mass capture rates ~30lbm/s

10X refers to hypersonic systems with mass capture rates ~100 lbm/s

C.3.6 FACILITY EXHAUST SYSTEM

The test duration time requirement necessitates that the facility have appropriate means of exhaust gas handling. An air ejector solution is not affordable given the large amount of HPA storage required for mission duration runtimes at the required conditions. To achieve mission duration runtimes, J5 will utilize both the A and B exhaust plants, which includes an exhaust gas spray cooling capability, water cooled diffuser, and system isolation valves. In recent infrastructure health assessment activities performed by AEDC, the ducting, valves, and controls for the exhaust duct were checked for operational readiness. J5 exhaust pumping and cooling capabilities are in place and require no recapitalization, only reactivation, of those portions that are not already active. Refurbishment or replacement of exhaust water flow control valves and other ancillary equipment was identified. A new diffuser section appropriately sized for the test capability will be necessary to properly entrain facility and test article exhaust gas.

C.3.7 VARIABLE MACH-NUMBER NOZZLE (VMN)

Current state-of-the-art freejet nozzle technologies only allow for single-point, steady state Mach number simulations. This requires multiple nozzles to certify High Speed systems over their entire flight envelope. Additionally, the ability to “fly the mission” or simulate flight trajectories does not exist with current test capabilities, but will be necessary for future development programs to meet required accuracy.

Future HS/H air breathing propulsion demonstration programs are primarily targeting a flight envelope that ranges from Mach 4.5 to 6.0, which is the threshold target range for a VMN capability. This target range is further validated due to current state-of-the-art logistically supportable fuels. For example, current fuel technologies limit the thermal management design space, limiting the ability for acquisition level air breathing hypersonic systems to fly much above Mach 6.0. Likewise, due to the compression characteristics of current hypersonic air breathing inlet systems, the starting or ignition boundaries are likely to be limited under Mach 4.5. The threshold value considers an achievable turn down ratio in a variable Mach number freejet nozzle based on past assessments completed by the T&E/S&T High Speed Systems Test (HSST) program and others. Turn down ratios greater than 2-3 Mach numbers have been shown to be inadequate in technical maturity, carrying high risk, and are cost prohibitive.

Project Phoenix incorporates design and validation of a revolutionary freejet VMN for implementation into the J5 facility that will maintain well-conditioned flow while the flight Mach number varies continuously from Mach 4.5 – 6 (threshold) and 4 – 6.5 (Objective). This design will leverage Government-Furnished Information (GFI) for a concept validated in the HAPCAT pilot scale facility. The VMN will address a critical need for ground testing facilities that will enable continuous testing over a range of Mach numbers. This is not possible with existing facilities, which operate at fixed Mach numbers.

C.3.8 YsZ RSH SYSTEM

Development and characterization of HS/H propulsion systems, including advanced combined cycle, ducted-rocket, ramjet, boost-glide, and scramjet systems requires ground test facilities that simulate flight representative test conditions from Mach 3.5 to 7.5. Clean, non-vitiated air delivered to the test article at representative stagnation pressures and temperatures encountered in atmospheric flight is not currently available for hypersonic system development. A clean-air

hypersonic test facility is necessary to provide a test medium having the chemical composition that will be encountered during atmospheric flight. The Mach 6 capability delivered by the AL RSH System satisfies near term air-breathing hypersonic system development as well as unprecedented test capabilities for other hypersonic systems, such as boost-glide type systems. The YsZ RSH (also referred to as a YsZ storage heater) will enhance the Mach 6 test capability for future air-breathing hypersonic system development and provide a significant test capability expansion, currently unavailable to the hypersonic community, for near and far term boost-glide system development.

To satisfy the heat storage requirements for this facility capability, two YsZ storage heaters and associated components and subsystems will be required. This design will leverage GFI for a concept validated in the previously mentioned HAPCAT pilot scale facility.

C.4 OBJECTIVE

The objective of the development of the Project Phoenix capability is to deliver a complete, operational test capability for Hypersonic ground T&E over the course of three Blocks. Each Block will provide a unique test capability not found anywhere else in the world.

Block 1 – Mach 6 Clean-Air Hypersonic Test Capability

Block 1 will utilize RSH with AL refractory to achieve true temperature clean-air test conditions with fixed area ratio facility nozzles. At the conclusion of Block 1, a fully operational test facility capable of Mach 6.0 clean-air ground test simulations will be available for hypersonic weapon system development. Block 1 will also incorporate provisions for extended runtime to appropriately test weapons systems to their full design capability on the ground prior to flight. Finally, Block 1 will be completed with the inclusion of an MIS with variable angle of attack and angle of sideslip to better simulate mission representative vehicle attitudes for accurate performance and operability characterization. The date of completion/delivery of Block 1 under this TO is scheduled for No Later Than (NLT) April 30, 2021.

Block 2 – Variable Mach Number Test Capability

Block 2 will progress the unprecedented hypersonic test capability produced by Block 1 with the incorporation of a VMN to achieve accurate ground test trajectory simulation. With the incorporation of a VMN, testers will be able to simulate a complete flight representative test article trajectory, increasing the data capture within a single run while significantly reducing risk to the subsequent flight test program. The date of completion/delivery of Block 2 under this TO is scheduled for NLT April 30, 2022.

Block 3 – Mach 7.5 Clean-Air Hypersonic Test Capability

The Project Phoenix capability will culminate in Block 3 with the addition of a second RSH system utilizing YsZ refractory. The incorporation of the YsZ heaters will boost the clean-air, true-temperature Mach number capability from Mach 6.0 to 7.5. The date of completion/delivery of Block 3 under this TO is scheduled for NLT April 30, 2023.

C.5 TASKS

C.5.1 TASK 1 – PROVIDE PROJECT MANAGEMENT

The contractor shall provide project management support under this TO. This includes the management and oversight of all activities performed by contractor personnel, including subcontractors, to satisfy the requirements identified in this Performance Work Statement (PWS).

C.5.1.1 SUBTASK 1 – TRANSITION-IN/OUT

C.5.1.1.1 TRANSITION-IN

The contractor shall update the draft Transition-In Plan (Section F, Deliverable 1) provided with its proposal and provide a final Transition-In Plan as required in Section F (Section F, Deliverable 2). The contractor shall ensure that there will be minimum service disruption to vital Government business and no service degradation during and after transition. The contractor shall implement its Transition-In Plan following approval of the final Transition-In Plan and all transition activities shall be completed NLT 30 calendar days after approval of the final Transition-In Plan.

Prior to the start of transition, the contractor shall schedule, coordinate, and host a Project Kick-Off Meeting at the location approved by the Government (Section F, Deliverable 3). The meeting will provide an introduction between the contractor personnel and Government personnel who will be involved with the TO. The meeting will provide the opportunity to discuss transition activities; roles and responsibilities and lines of communication between contractor and Government personnel; technical, management, and security issues; purchasing and travel authorization and reporting procedures. At a minimum, the attendees shall include Key contractor Personnel (including key subcontractor personnel), representatives from the directorates, other relevant Government personnel, and the FEDSIM Contracting Officer's Representative (COR).

C.5.1.1.2 TRANSITION-OUT

The contractor shall provide Transition-Out support when required by the Government. The Transition-Out Plan shall facilitate the accomplishment of a seamless transition from the incumbent to an incoming contractor/Government personnel at the expiration of the TO. The contractor shall provide a draft Transition-Out Plan within six months of Project Start (PS) (Section F, Deliverable 4). The Government will work with the contractor to finalize the Transition-Out Plan (Section F, Deliverable 5) in accordance with Section E. At a minimum, this Transition-Out Plan shall be reviewed and updated on an annual basis (Section F, Deliverable 6). Additionally, the Transition-Out Plan shall be reviewed and updated quarterly during the final Option Period (Section F, Deliverable 6).

In the Transition-Out Plan, the contractor shall identify how it will coordinate with the incoming contractor and/or Government personnel to transfer knowledge regarding the following:

- a. Project management plans and processes.
- b. Points of contact.
- c. Location of technical and project management documentation.

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- d. Status of ongoing technical initiatives.
- e. Facility operational information and training.
- f. Facility maintenance information and training.
- g. Facility inventory information.
- h. Appropriate contractor to contractor coordination to ensure a seamless transition.
- i. Transition of Key Personnel.
- j. Schedules and milestones.
- k. Actions required of the Government.

The contractor shall also establish and maintain effective communication with the incoming contractor/Government personnel for the period of the transition via weekly status meetings or as often as necessary to ensure a seamless Transition-Out.

The contractor shall implement its Transition-Out Plan NLT six months prior to expiration of the TO or as required by the Government.

C.5.1.2 SUBTASK 2 – CONTRACT MANAGEMENT

The contractor shall perform contract management duties as required throughout the performance of the TO. This includes financial, technical, and administration tasks that are primarily contractual in nature.

Specific requirements under this subtask include, but are not limited to:

- a. Conducting a kick-off meeting for each of the major Blocks (Section F, Deliverable 7).
- b. Conducting technical status meetings, as required, to inform the Government of project activity throughout TO performance.
- c. Developing and presenting a Monthly Status Report (MSR) (Section J, Attachment F) (Section F, Deliverable 8) in accordance with the MSR template. The MSR shall be uploaded to the Hypersonic Test and Evaluation Investment Program (HyTIP) Knowledge Management System (KMS) NLT the 15th of each month.
- d. Delivering a Project Schedule (via Microsoft Project® format) (Section F, Deliverable 9) to the HyTIP Technical Point of Contact (TPOC) and FEDSIM COR monthly.
- e. Conducting financial management activities to include forecasting, tracking, and reporting TO costs.
- f. Tracking and reporting deliverable progress.
- g. Preparing, tracking, and managing trip reports for travel requests. All travel shall be approved by the Government and trip reports will be specified, as required (Section F, Deliverable 10). At a minimum, trip reports shall be prepared with the information provided in Section J, Attachment G.
- h. Providing a monthly Earned Value Management (EVM) report in accordance with the HyTIP standard template (Section J, Attachment R) (Section F, Deliverable 11).
- i. Communicating and reporting any contractual related issues such as security, personnel/staffing, and subcontract management.
- j. Providing spend plans (e.g., projected cost per CLIN) for at least 12 months. Spend plans shall be formatted to applicable Test Resource Management Center (TRMC) standards.

C.5.1.3 SUBTASK 3 – PROJECT ADMINISTRATION

The contractor shall provide project administration duties throughout the performance of the TO to include coordinating, planning, reporting, scheduling, and logistics. This activity may require communication with subcontractors, third party contractors (e.g., base operating contractor), and the Government, as required.

A key aspect of project administration includes the Project Management Plan (PMP). The contractor shall provide a PMP (Section F, Deliverable 12) to describe the proposed management approach, Work Breakdown Structure (WBS), milestones, risk management, and communications plan for each task and subtask. The PMP is an evolutionary document that shall be updated annually at a minimum (Section F, Deliverable 13). The contractor shall work from the latest Government-approved version of the PMP.

Given the complexity of this TO, the Government may leverage Project Work Orders (PWO) to support project communication and re-baseline expectations around project performance, cost, and schedule. The PWOs will provide further technical and management guidance or clarity on a WBS element in execution of the tasks but shall not modify the existing scope of support required under the TO. The contractor shall provide project-related details requested in response to the PWO such as work activities, projected schedules and milestones, and related man-hours and resources required.

Throughout performance, the contractor shall utilize the HyTIP KMS to archive technical project information at the request of the HyTIP Program Management Office (PMO). In addition, the contractor shall provide a project administration tool for tracking and reporting up-to-date project progress with the ability to forecast project information. The contractor's project administration tool shall be made accessible to the Government and display up-to-date relevant project cost and schedule information related to ongoing activities under the TO.

C.5.1.4 SUBTASK 4 – QUALITY CONTROL

The contractor shall deliver services and products utilizing the highest quality standards to ensure final deliverables meet the intended metrics and objectives under the TO. The contractor shall adhere to policies and procedures identified throughout the TO. The contractor shall inform the Government immediately upon identification of quality related issues.

The contractor shall identify and describe its approach and methodology for providing quality control in meeting the TO requirements within a Quality Control Plan (QCP). The contractor shall fully discuss its validated processes and procedures that provide high quality performance for each Task Area. The QCP shall describe how the processes integrate with the Government's requirements.

The contractor shall update and provide a final QCP (Section F, Deliverable 14) NLT ten days after the Kick-Off meeting. The contractor shall provide updates, as required, throughout TO performance.

C.5.1.5 SUBTASK 5 – SYSTEM ENGINEERING (SE)

SE is inherent to the execution of all tasks and subtasks outlined in this TO. The contractor shall provide SE throughout execution of the TO to effectively reduce the technical and programmatic risk of Project Phoenix. The contractor shall utilize the AEDC Organizational SE Instruction

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(AEDCI 63-101) as a framework for application in processes, practices, and principles. The contractor shall tailor SE processes appropriately to support decision making at the lowest level possible to ensure best value is delivered while managing cost, schedule, and technical risk.

C.5.1.6 SUBTASK 6 – SAFETY PLAN

The contractor shall develop a Safety Plan (Section F, Deliverable 15) for any demolition, installation, and checkout work to identify hazards associated with project implementation. The Safety Plan shall identify the high level risks of the installation work. All risks shall be mitigated below Medium as defined in AEDC Safety, Health, and Environmental (SHE) Standard A6. All work stoppages due to unsafe conditions shall be at the contractor's expense and will not be grounds for outage extension.

The contractor shall be responsible for ensuring all its personnel abide by the approved safety plan and wear the appropriate Personnel Protection Equipment (PPE) in accordance with AEDC standards.

**C.5.1.7 SUBTASK 7 – ACCOUNTING FOR CONTRACTOR MANPOWER
REPORTING**

The contractor shall report ALL contractor labor hours (including subcontractor labor hours) required for performance of services provided under this contract for the AEDC via a secure data collection site. The contractor shall completely fill in all required data fields using the following web address: <http://www.ecmra.mil/>.

Reporting inputs will be for the labor executed during the period of performance during each Government Fiscal Year (FY), which runs October 1 through September 30. While inputs may be reported any time during the FY, all data shall be reported no later than October 31 of each calendar year. Contractors may direct questions to the support desk at: <http://www.ecmra.mil/>.

Contractors may use Extensible Markup Language (XML) data transfer to the database server or fill in the fields on the website. The XML direct transfer is a format for transferring files from a contractor's systems to the secure website without the need for separate data entries for each required data element at the website. The specific formats for the XML direct transfer may be downloaded from the web.

**C.5.2 TASK 2 – PROVIDE A MACH 6 CLEAN-AIR HYPERSONIC TEST
CAPABILITY [BLOCK 1]**

C.5.2.1 SUBTASK 1 – DESIGN

Successful completion of Block 1 includes an integrated design of the following systems:

- a. HPA System
- b. AL RSH System
- c. ADS
- d. Test Facility and Test Article Services
- e. MIS/FMS
- f. Facility Exhaust System

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To date, the Government has defined Key System Requirements (KSRs) and specifications for each of the identified systems which will be made available as Government Furnished Information (GFI). In route to a final integrated design, the contractor shall complete design reviews to include a Conceptual Design Review (CoDR), Preliminary Design Review (PDR), Critical Design Review (CDR), and a Final Design Review for the identified systems. Each review represents a stage of completion (i.e., CoDR – 10% complete; PDR – 30% complete; CDR – 90% complete; Final – 100% complete). Design reviews have been completed for some systems while others are still early in the design process. The Government will furnish system analysis and current design documentation as GFI (Section J, Attachment K). The contractor shall review all design documentation provided as GFI (Section J, Attachment K) and assess each design to ensure feasibility in integration. The contractor shall provide feedback and/or propose alternatives as needed to the design documentation provided as GFI (Section F, Deliverable 16).

The contractor shall maximize communication and ensure that the Government is fully informed during the design process. Preliminary procurement strategy of long-lead items shall be communicated early in the design process as part of the CoDR to ensure the overall development schedule can be achieved. The total Bill of Material (BOM) for equipment procurement for the designed systems shall be presented and reviewed at each PDR and CDR, as necessary, with procurement specifications of all system materials and components communicated, as appropriate, during the design review process. Before proceeding to the next stage in the Design Review process, the contractor shall address Government comments made during the design reviews. The final design shall meet the specifications and KSRs identified as GFI (Section J, Attachment K) and shall not alter the intent or function of the system. Final design shall be approved by the Government.

Standardization of facility components between the Project Phoenix Facility and APTU shall be incorporated into the design process to the fullest extent possible. The Project Phoenix Facility shall be designed for maximum commonality and standardization with the other AEDC facilities and their supporting infrastructure. Designs shall be compliant with applicable design and engineering industry and AEDC standards.

C.5.2.1.1 HPA SYSTEM

The HPA design is currently at the Interim Design (60% completion) stage of completion. The contractor shall progress the current design to a final design (Section F, Deliverable 17) of the HPA system to include all components, support systems required, controls and instrumentation, and other supporting subsystems. The contractor shall ensure current design documentation provided as GFI (Section J, Attachment K) is assessed for feasibility in implementation and provide feedback or propose alternatives to support the complete integration of Block 1 systems. The contractor shall complete a CDR in route to a final design (Section F, Deliverable 17).

Specific design requirements shall address the following:

- a. HPA system components, piping, valves, and safety components to accommodate interface requirements at the AL RSH HPA connections.
- b. HPA system components, piping, valves, and safety components to accommodate interface requirements of ADS HPA connection.

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- c. HPA system components, piping, valves, and safety components to accommodate future interface requirements of future YsZ RSH HPA connections.
- d. HPA system components, piping, valves, and safety components to accommodate integration of the new HPA system to existing base infrastructure including the specific design associated with the physical connection to the base HPA delivery system.
- e. Pressure vessel size and quantity.
- f. Pressure vessel foundation requirements.
- g. Pressure piping support requirements, where necessary, to connect the new HPA system to existing APTU bottle farm and base HPA compression systems and facility components, as described above.
- h. Cost and schedule projections for procurement items during the design stages (e.g., Pressure vessel procurement, isolation valves, foundations for the pressure vessels, and foundations for piping supports).
- i. Valve specifications consistent with design operating conditions.
- j. HPA subsystem designs.
- k. HPA system and subsystem utility requirements.
- l. Controls and instrumentation design for inclusion into the master Facility Control System (FCS).
- m. Cycle life analysis.
- n. Design criteria and requirement definition.
- o. Interface Control Document (ICD) up to specified points of connection.
- p. Process and instrumentation diagrams (P&IDs).
- q. Final drawings complete with facility model integration.
- r. Integrated Concept of Operations (CONOPS).
- s. Failure Modes, Effects, and Criticality Analysis (FMECA).
- t. Maintenance requirements.

C.5.2.1.2 AL RSH SYSTEM

The AL RSH System design has achieved a final design (100% complete). The AL RSH System design includes pressure vessels, AL cored brick refractory heat sources, controls, and instrumentation for fabrication and implementation into the Hypersonic Test Capability Improvement (HTCI) facility. The contractor shall ensure current design documentation provided as GFI (Section J, Attachment K) is assessed for feasibility for implementation and provide feedback or propose alternatives to support the complete design integration of Block 1 systems.

Specific design requirements shall address the following:

- a. RSH system design compliant with ASME Boiler and Pressure Vessel Code (BPVC)
- b. RSH assembly design
- c. Refractory design
- d. Burner assembly design
- e. Reheat capability
- f. Heater blower and exhaust system design

- g. Natural gas supply design
- h. HPA supply piping and valve design up to a specified point of connection
- i. Water cooling system design
- j. Cost and schedule projections for procurement items
- k. Controls and instrumentation design
- l. Facility integration design
- m. Performance prediction calculations
- n. Design criteria and requirement definition
- o. ICD up to specified points of connection
- p. P&IDs
- q. Final drawings complete with facility model integration
- r. Integrated CONOPS
- s. FMECA
- t. Maintenance requirements

C.5.2.1.3 ADS

The ADS design is has achieved Preliminary Design (30% Complete). The contractor shall progress the current design to a final design of the ADS to include heater isolation, heater pit, and support subsystems required to support the heat-up, standby, reheat, pressurization, blowdown, and cooldown of the HTCI facility, as needed. The contractor shall review current design documentation provided as GFI (Section J, Attachment K) to assess the feasibility for implementation, provide feedback and/or propose alternatives, and progress the design to support the complete integration of Block 1 systems. The contractor shall complete a CDR in route to a final design (Section F, Deliverable 18).

Specific design requirements shall address the following:

- a. ADS assembly design from two AL RSH Outlets, provisions for future integration of YsZ RSH System, and ambient HPA to a facility nozzle inlet location provided as GFI.
- b. Analysis of conceptual estimations of YsZ RSH system flowrates to develop interfacing duct sizes based on final operating requirements of the HTCI facility as described in the Test Capability Requirements Document (TCRD).
- c. ADS subsystem design.
- d. ADS utility requirements.
- e. Heater pit integration design.
- f. Mixing validation analysis of multiple process air streams of varying temperature (nominally 4500°R, 3500°R, and ambient air streams at a maximum pressure of 2500 PSI). Mixed process airflow pressure and temperature uniformity objective of plus or minus (\pm) two percent spatially at facility nozzle inlet.
- g. Heater isolation assembly design.
- h. Heater isolation subsystem design.
- i. Heater isolation utility requirements.
- j. Controls and instrumentation design for inclusion into the master FCS.
- k. Facility integration design.

- l. Performance prediction calculations.
- m. Cost and schedule projections for large procurement items.
- n. Design criteria and requirement definition.
- o. ICD up to specified points of connection.
- p. P&IDs.
- q. Final drawings complete with facility model integration.
- r. Integrated CONOPS.
- s. FMECA.
- t. Maintenance requirements.

C.5.2.1.4 TEST FACILITY AND TEST ARTICLE SERVICES

The Test Facility and Test Article Services design has not been developed. The contractor shall develop the test facility and test article services design required to reestablish J5 as a functioning test facility. The contractor shall complete a CoDR, PDR, and CDR in route to a final design (Section F, Deliverable 19). System designs shall be field routed, as necessary. The contractor shall be responsible for defining points of connection information for each subsystem design listed in this section to ensure seamless integration and operation with existing and new systems developed as part of this project. Specific design requirements shall be coordinated with the Government upon initiation of the design task. Specific design requirements shall address the following:

- a. Cost and schedule projections for procurement items.
- b. Design criteria and requirement definition.
- c. ICD up to specified points of connection.
- d. P&IDs.
- e. Final drawings complete with facility model integration.
- f. Integrated CONOPS.
- g. FMECA.
- h. Maintenance requirements.

In addition, the design requirements shall incorporate the subsystem/component design requirements described in the following subsections of C.5.2.1.4.

C.5.2.1.4.1 TEST FACILITY/TEST ARTICLE SUBSYSTEMS

The contractor shall develop a design for the Test Article/Test Facility Subsystems including shop air, hydraulics, nitrogen, oxygen, electrical, natural gas, and water systems (high, medium, and low pressure). The design shall be submitted as a part of the overall Test Facility and Test Article Services design.

The contractor shall design a new shop air distribution system required for valve actuation muscle air, instrumentation cooling, and instrumentation purges. Basic system architecture may include pressure control valves, flow control valves, and isolation valves and pressure and temperature measurements in order to establish system operation. The system shall interface with the AEDC shop air distribution network.

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The contractor shall design a new hydraulic system required for valve actuation muscle. A hydraulic system does not currently exist as part of the existing Phoenix infrastructure.

The contractor shall design a new nitrogen distribution system required for instrumentation cooling, instrumentation purges, and pad pressures on tanks. Basic system architecture may include pressure control valves, flow control valves, and isolation valves and pressure and temperature measurements in order to establish system operation. The system shall interface with the AEDC nitrogen distribution network. Provisions for designs that may require open- or closed-loop control operation shall be included.

The contractor shall design a new base raw water distribution system for cooling various systems associated with the Project Phoenix capability. The system should be capable of supplying, monitoring, and controlling water flow to the J5 Exhaust Diffuser, the Facility Exhaust Sprays located in the exhaust duct, the water supply line to the test cell, and the Test Cell Water Deluge System. Basic system architecture may include interface definition for control authority over pumps, pressure control valves, flow control valves, and isolation valves and pressure and temperature measurements in order to establish system operation. The system shall interface with the AEDC raw water distribution network. Provisions for designs that may require open- or closed-loop control operation shall be included. Medium and high pressure water systems are also required to meet the cooling requirements of the Project Phoenix systems and subsystems, where necessary.

The contractor shall design a new liquid oxygen system required to establish YsZ burner flame temperatures required to establish maximum temperature storage. Basic system architecture shall include interface definition for control authority over a local control system responsible for operation of pressure control valves, flow control valves, and isolation valves and pressure and temperature measurements in order to establish system operation. No liquid oxygen system currently exists in the Project Phoenix system infrastructure.

Electrical/Local power infrastructure shall be established by the contractor, as required by the final designs of the included Project Phoenix systems and subsystems, to include power requirements from existing systems located at Buildings 522 and 531.

The establishment of local natural gas service, as documented by the AL RSH system final design and provisions for future YsZ Heater System operation, is required by the contractor

C.5.2.1.4.2 TEST ARTICLE FUEL AND IGNITION SYSTEMS

The contractor shall develop a design a test cell fuel system to be installed at the J5 facility to provide pressurized fuel to various test articles. This system shall be monitored and controlled using the J5 facility control system. Basic system architecture shall include interface definition for control authority over pumps, pressure control valves, flow control valves, and isolation valves and pressure and temperature measurements in order to establish system operation.

The contractor shall design a silane system to be installed at the J5 facility to serve as a test article ignition aid. This system shall be monitored and controlled using the J5 FCS system. Basic system architecture shall include interface definition for control authority over pumps, pressure control valves, flow control valves, and isolation valves and pressure and temperature measurements in order to establish system operation.

C.5.2.1.4.3 TEST FACILITY FIRE SUPPRESSION

The contractor shall design a test facility fire suppression system meeting applicable fire and safety codes.

C.5.2.1.4.4 TEST FACILITY SECURITY

The contractor shall design a test facility security system and operational plan to meet security classification requirements of future test programs.

C.5.2.1.4.5 TEST FACILITY/TEST ARTICLE FLOW SURVEY INSTRUMENTATION FUEL AND IGNITION SYSTEMS

The contractor shall design nozzle exit flow survey apparatus to allow for facility performance assessment. Measurement types include pressure, temperature, and gas composition.

C.5.2.1.5 INTEGRATED TEST FACILITY CONTROL SYSTEM (FCS)

The Integrated Test FCS design has achieved Preliminary Design (30% completion). The contractor shall progress the preliminary design to a final design. The contractor shall complete a CDR in route to a final design (Section F, Deliverable 20).

Specific design elements include, but are not limited to:

- a. Acquisition of instrumentation channels identified and refined.
- b. Provisions for test article control system channel recording and control system event monitoring.
- c. Implementation of Inter-Range Instrumentation Group (IRIG) Timecode Distribution Source.
- d. Timestamp of data acquired consistent with legacy AEDC resolution.
- e. Synchronization of all data sources to IRIG Timecode Distribution Source.
- f. Design of signal conditioning subsystem supporting channels identified and refined.
- g. Interface for control of signal conditioning features and diagnostics.
- h. Data quality requirements shall be coordinated, where appropriate, to satisfy system operating requirements.
- i. Measurement Processing.
- j. Measurement Visualization.
- k. Measurement Recording and Processed Data Output.
- l. Control Room/Data Acquisition Center room partition verification.
- m. Data Acquisition (DAQ) Console Design (Equipment and Placement).
- n. Wire/cable conduit and routing within the J5 Local Electronics Building (LEB) terminating at the J5 Test Building (Provisions for classified data handling shall be included).
- o. Data acquisition equipment rack placement.
- p. Analysis station monitor and display design.
- q. Utility requirements for equipment operation.
- r. ICD up to specified points of connection with the following systems: AL RSH System, subsystems and utilities; YsZ RSH System, subsystems and utilities; ADS; HPA System

to include integration with existing base HPA distribution network; Facility and Infrastructure including Test Article Systems and Subsystems; Facility Exhaust System; Fuel and Silane/Ignition Systems; and Test Cell Supply Media (Shop Air, Nitrogen, Instrument Air, and Water).

- s. P&IDs.
- t. Final component drawings/layout.
- u. Calibration and/or Maintenance requirements.

C.5.2.1.6 INTEGRATED TEST FACILITY/TEST ARTICLE INSTRUMENTATION AND DATA ACQUISITION SYSTEM (DAS)

The Integrated Test Article/Test Facility Instrumentation and DAS design has achieved Preliminary Design (30% completion). The contractor shall progress the preliminary design to a final design. The contractor shall complete a CDR in route to a final design (Section F, Deliverable 21).

Specific design elements include, but are not limited to:

- a. Acquisition of instrumentation channels identified and refined.
- b. Provisions for test article control system channel recording and control system event monitoring.
- c. Implementation of IRIG Timecode Distribution Source.
- d. Timestamp of data acquired consistent with legacy AEDC resolution.
- e. Synchronization of all data sources to IRIG Timecode Distribution Source.
- f. Design of signal conditioning subsystem supporting channels identified and refined.
- g. Interface for control of signal conditioning features and diagnostics.
- h. Data quality requirements shall be coordinated, where appropriate, to satisfy system operating requirements.
- i. Measurement Processing.
- j. Measurement Visualization.
- k. Measurement Recording and Processed Data Output.
- l. Control Room/Data Acquisition Center room partition verification.
- m. DAQ Console Design (Equipment and Placement).
- n. Wire/cable conduit and routing within the J5 LEB terminating at the J5 Test Building (Provisions for classified data handling shall be included).
- o. Data acquisition equipment rack placement.
- p. Analysis station monitor and display design.
- q. Utility requirements for equipment operation.
- r. ICD up to specified points of connection with the following systems: AL RSH System, subsystems and utilities; YsZ RSH System, subsystems and utilities; ADS; HPA System to include integration with existing base HPA distribution network; Facility and Infrastructure including Test Article Systems and Subsystems; Facility Exhaust System; Fuel and Silane/Ignition Systems; and Test Cell Supply Media (Shop Air, Nitrogen, Instrument Air, and Water).
- s. P&IDs.

- t. Final component drawings/layout.
- u. Calibration and/or Maintenance requirements.

C.5.2.1.7 MODEL INJECTION/FORCE MEASUREMENT SYSTEM (MIS/FMS)

The MIS/FMS design has achieved a Preliminary Design (30%). The contractor shall progress the current design to a final design to include support systems, controls and instrumentation, and other supporting subsystems, as required, for implementation into the HTCI facility. The contractor shall review current design documentation provided as GFI (Section J, Attachment K) to assess the feasibility for implementation, provide feedback and/or propose alternatives, and progress the design to support the complete integration of Block 1 systems. The contractor shall complete a CDR in route to a final design (Section F, Deliverable 22).

Specific design requirements shall address the following:

- a. MIS Components.
- b. MIS controls and instrumentation (up to defined points of connection).
- c. MIS support equipment.
- d. MIS placement, placement flexibility features, and required supporting computational models.
- e. Test cabin/anchor modifications (Replacement of the test cabin; however, utilizing existing hatches)
- f. Utility requirements.
- g. FMS Components.
- h. FMS Controls and Instrumentation (up to defined points of connection).
- i. FMS support equipment.
- j. Calibration hardware/process.
- k. Cost and schedule projections for procurement items.
- l. Design criteria and requirement definition.
- m. ICD up to specified points of connection.
- n. P&IDs.
- o. Final drawings complete with facility model integration.
- p. Integrated CONOPS.
- q. FMECA.
- r. Maintenance requirements.

C.5.2.1.8 FACILITY EXHAUST SYSTEM

The Facility Exhaust System has not been designed. The contractor shall develop a design of the facility exhaust system to include refurbishing exhaust system components required for operation and design of a new diffuser insert for increased exhaust performance. The contractor shall complete a CoDR, PDR, and CDR in route to a final design (Section F, Deliverable 23). Items identified for replacement will be provided as GFI. A Government assessment on the predicted exhaust performance and optimization will be provided as GFI. The contractor shall inspect the exhaust system and either concur with the Government's health assessment of the facility exhaust system or provide alternate recommendations for consideration prior to design.

Specific design requirements shall address the following:

- a. Exhaust system spray cooling component refurbishment.
- b. New J5 diffuser insert.
- c. Design criteria and requirement definition.
- d. ICD up to specified points of connection.
- e. Cost and schedule projections for procurement items.
- f. P&IDs.
- g. Final drawings complete with facility model integration.
- h. Integrated CONOPS.
- i. FMECA.
- j. Maintenance requirements.

C.5.2.2 SUBTASK 2 – DEVELOPMENT

The development phase of Block 1 will apply a range of services to include purchasing, fabrication, factory testing, and logistics for all applicable Block 1 system components. The contractor shall develop system components based on approved designs and specifications. The development of such specialized components requires fabrication of materials and equipment from qualified sources.

The contractor shall identify material and equipment purchasing lead times for all items as a part of the design process. The contractor shall ensure lead times remain up-to-date and are accurately reflected within the project schedule.

All primary components procured as part of this effort shall be pre-tested, where possible, at the vendor facility. The contractor shall perform factory acceptance testing on critical components as required by the Government. The contractor shall schedule and notify the Government of factory acceptance testing at least two weeks in advance to allow Government personnel to attend.

Following delivery of the primary components, the contractor shall conduct onsite acceptance testing. The contractor shall schedule and notify the Government of onsite acceptance testing at least one week in advance of onsite accepting testing. The contractor shall provide a final documented inspection report for all acceptance testing performed on components (Section F, Deliverable 24).

The contractor shall perform all logistics functions associated with planning, implementing, and controlling procedures for the efficient and effective transportation, offloading, and storage of components including services and related information from the point of origin to final place of installation.

The contractor shall identify all equipment warranty information (Section F, Deliverable 47) as required for the equipment purchased.

The contractor shall utilize applicable CLINs for material and equipment purchasing and ancillary services as required in section H.12. Purchasing is subject to Government approval and the purchasing guideline identified in Section H.11 of this TO.

C.5.2.3 SUBTASK 3 – ENGINEERING AND INTEGRATION

The contractor shall perform engineering and integration services as required to install all necessary components for operation of the systems. The integration of components shall follow all specified activities approved in drawings, specifications, and instructions approved by the Government in the final designs.

The contractor shall perform logistics functions and organization of equipment before, during, and after installation activities to include demolition, removal, and disposal of antiquated or unnecessary equipment during the process of installation of equipment or components associated with the completion of this effort. Removal/disposal of equipment shall be conducted in accordance with AEDC policies and procedures.

Ancillary support may be required during the engineering and integration of components. Ancillary support includes such services performed by machinists, boilermakers, welders, pipefitters, and other craft disciplines where an OASIS labor category does not exist (see also section H.12 of the TO).

Prior to installation, the contractor shall confirm the feasibility for integration of systems. If alternate approaches or solutions to integration are identified, the contractor shall communicate the appropriate detail to the Government for consideration and authority to proceed with the alternative.

The contractor shall provide a final report documenting installation details, data collected, as-built and as-installed schematics, and final as-built and as-installed drawings (to include Three-Dimensional (3D) Computer-Aided Design (CAD) models) (Section F, Deliverable 25).

The contractor shall perform Configuration Management (CM) duties on systems as needed throughout performance of the TO in accordance with standard AEDC protocols and best practices.

C.5.2.4 SUBTASK 4 – VERIFICATION AND TESTING

The contractor shall checkout all system components and subsystems required for operation. The contractor shall verify the system against its primary operation metrics identified in the designs to ensure the overall capability of the test facility can be achieved.

The contractor shall deliver a final report for component-level testing that documents data collected, test data, test data analysis, conclusions and recommendations (Section F, Deliverable 26). Each report shall be in AEDC Technical Report (TR) format and shall be delivered to the Government NLT 30 days after final testing is complete. Upon approval, the Final TR shall have a Distribution Statement International Traffic in Arms Regulations (ITAR) and be non-proprietary.

C.5.2.4 SUBTASK 5 – EXIT CRITERIA

The contractor shall demonstrate a clean-air hypersonic test capability up to Mach 6 at extended runtimes to include:

- a. Clean-air steady state and transient facility operation at relevant pressures and temperatures to simulate atmospheric flight conditions over a range from Mach 3.5 to Mach 6.

- b. Model injection integrated system operation.
- c. Force measurement integrated system operation.
- d. Variable Angle of Attack and Variable Angle of Sideslip integrated system operation.
- e. Exhaust system integrated system operation.
- f. Test Facility and Test Article Services integrated system operation.

The exit criteria shall address the final delivery of all component systems and subsystems (Section F, Deliverable 27). The contractor shall deliver a final report for the integrated test capability that documents data collected, test data, test data analysis, conclusions, and recommendations (Section F, Deliverable 28). Each report shall be in AEDC TR format and shall be delivered to the Government NLT 60 days after final testing is complete. Upon approval, the Final TR shall have a Distribution Statement D/ITAR and be non-proprietary.

C.5.3 TASK 3 – PROVIDE A VARIABLE MACH-NUMBER NOZZLE (VMN) [BLOCK 2]

C.5.3.1 SUBTASK 1 – DESIGN

The current VMN technology is being matured through the pilot scale facility called HAPCAT. The design of the VMN will leverage the technology design validated in the HAPCAT pilot scale facility which will be incorporated into the TO as GFI. The contractor shall review all design documentation provided as GFI and assess the VMN design to ensure feasibility in integration. The contractor shall provide feedback and/or propose alternatives as needed to the design documentation provided as GFI (Section F, Deliverable 29). The contractor shall work to complete the design concept in tandem with the Government which will serve as the baseline for the VMN hardware design. The contractor shall define points of connection information for each subsystem design listed as a subtask in this section to ensure seamless integration and operation with existing and new systems developed as part of this project. The contractor shall identify facility operating conditions, overall facility CONOPS, and subsystem requirements.

Specific design requirements shall address the following:

- a. Nozzle Aero-Mechanical
- b. Stilling Chamber
- c. High Pressure Cooling Water System
- d. Controls and Instrumentation
- e. Facility Integration
- f. Design Reviews
- g. Cost and schedule projections for purchasing items
- h. Design Criteria and Requirement Definition
- i. ICDs up to specified points of connection for primary components and subsystems
- j. P&IDs
- k. Component Level System Safety Hazard Analysis (SSHA)
- l. Integrated CONOPS
- m. FMECA
- n. Maintenance Requirements

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The contractor shall complete a CoDR, PDR, CDR, and final design (Section F, Deliverable 30). The contractor shall maximize communication and ensure that the Government is fully informed during the design process. Preliminary purchasing strategy of long-lead items shall be communicated early in the design review process as part of the CoDR to ensure the overall VMN schedule objective can be achieved. The total BOM for equipment for the VMN system shall be presented and reviewed at the VMN CoDR, PDR and CDR, as necessary, with purchasing specifications of all VMN system materials and components communicated, as appropriate, during the design review process.

Standardization of facility components between the Project Phoenix Facility and APTU shall be incorporated into the design process to the fullest extent possible. The Project Phoenix Facility must be designed for maximum commonality and standardization with the other AEDC facilities and their supporting infrastructure. Designs shall be compliant with applicable design and engineering industry and AEDC standards.

C.5.3.2 SUBTASK 2 – DEVELOPMENT

The development phase of Block 2 will apply a range of services to include purchasing, fabrication, factory testing, and logistics of all applicable Block 2 system components. The contractor shall develop system components based on approved designs and specifications. The development of such specialized components requires fabrication of materials and equipment from qualified sources.

The contractor shall identify material and equipment purchasing lead times for all items as a part of the design process. The contractor shall ensure lead times remain up-to-date and are accurately reflected within the project schedule.

All primary components procured as part of this effort shall be pre-tested, where possible, at the vendor facility. The contractor shall perform factory acceptance testing on critical components as required by the Government. The contractor shall schedule and notify the Government of factory acceptance testing at least two weeks in advance to allow Government personnel to attend. Following delivery of the primary components, the contractor shall conduct onsite acceptance testing. The contractor shall schedule and notify the Government of onsite acceptance testing at least one week in advance of onsite accepting testing. The contractor shall provide a final documented inspection report for all acceptance testing performed on components (Section F, Deliverable 31).

The contractor shall perform all logistics functions associated with planning, implementing, and controlling procedures for the efficient and effective transportation, offloading, and storage of components including services and related information from the point of origin to final place of installation.

The contractor shall identify all equipment warranty information (Section F, Deliverable 47), as required, for the equipment purchased.

The contractor shall utilize applicable CLINs for material and equipment purchasing and ancillary services as required in section H.12. Purchasing is subject to Government approval and the purchasing guideline identified in Section H.11 of this TO.

C.5.3.3 SUBTASK 3 – ENGINEERING AND INTEGRATION

The contractor shall perform engineering and integration services as required to install all necessary components for the VMN in the AEDC J5 Facility. The integration of components shall follow all specified activities approved in drawings, specifications, and instructions approved by the Government in the final designs.

The contractor shall perform logistics functions and organization of equipment before, during, and after installation activities to include demolition, removal, and disposal of antiquated or unnecessary equipment during the process of installation of equipment or components associated with the completion of this effort. Removal/disposal of equipment shall be conducted in accordance with AEDC policies and procedures.

Ancillary support may be required during the engineering and integration of components. Ancillary support includes such services performed by machinists, boilermakers, welders, pipefitters, and other craft disciplines where an OASIS labor category does not exist (see also section H.12 of the TO).

Prior to installation, the contractor shall confirm the feasibility for integration of systems. If alternate approaches or solutions to integration are identified, the contractor shall communicate the appropriate detail to the Government for consideration and authority to proceed with the alternative.

The contractor shall provide a final report documenting installation details, data collected, as-built and as-installed schematics, and final as-built and as-installed drawings (to include 3D CAD models) (Section F, Deliverable 32).

The contractor shall perform Configuration Management (CM) duties on systems as needed throughout performance of the TO in accordance with standard AEDC protocols and best practices.

C.5.3.4 SUBTASK 4 – VERIFICATION AND TESTING

The contractor shall checkout all system components and subsystems required for operation. The contractor shall verify the system against its primary operation metrics to ensure the overall capability of the test facility can be achieved.

The contractor shall deliver a final report for component-level testing that documents data collected, test data, test data analysis, conclusions, and recommendations (Section F, Deliverable 33). Each report shall be in AEDC TR format and shall be delivered to the Government NLT 30 days after final testing is complete. Upon approval, the Final TR shall have a Distribution Statement D/ITAR and be non-proprietary.

C.5.3.5 SUBTASK 5 – EXIT CRITERIA

This subtask shall include a demonstration test using the J5 Facility to vary pressure and temperature while the new VMN changes contours over a range from Mach 4.5 to 6 (Threshold). Pressure, temperature, and Mach number shall be measured in the test rhombus using suitable instrumentation to quantify the actual performance of the VMN in the J5 Facility in its final configuration. Suitable instrumentation for pressure and temperature measurement shall be provided by the contractor and verified for acceptance by the Government.

The exit criteria shall address the final delivery of all component systems and subsystems (Section F, Deliverable 34). The contractor shall deliver a final report for the integrated test capability that documents data collected, test data, test data analysis, conclusions, and recommendations (Section F, Deliverable 35). Each report shall be in AEDC TR format and shall be delivered to the Government NLT 60 days after final testing is complete. Upon approval, the Final TR shall have a Distribution Statement D/ITAR and be non-proprietary.

C.5.4 TASK 4 – PROVIDE A YsZ RSH SYSTEM [BLOCK 3]

C.5.4.1 SUBTASK 1 – DESIGN

The current YsZ RSH System technology is being matured through the pilot scale facility called HAPCAT. The design of the YsZ RSH will leverage the technology design validated in the HAPCAT pilot scale facility which will be incorporated into the TO as GFI. The contractor shall review all design documentation provided as GFI and assess the YsZ RSH design to ensure feasibility in integration. The contractor shall provide feedback and/or propose alternatives as needed to the design documentation provided as GFI (Section F, Deliverable 36). The contractor shall work to complete the specifications in tandem with the Government to serve as the baseline for the YsZ RSH Design. The contractor shall define points of connection information for each subsystem design listed as a subtask in this section to ensure seamless integration and operation with existing and new systems developed as part of this project. The contractor shall identify facility operating conditions, overall facility CONOPS, and subsystem requirements. The contractor shall complete the detailed design of the YsZ RSH system to meet facility capability requirements as defined by the Government.

Specific design requirements shall address the following:

- a. RSH system design compliant with ASME B&PVC
- b. RSH assembly design
- c. Burner assembly design
- d. Reheat capability
- e. Depressurization system
- f. Heater blower and exhaust system design
- g. Natural gas supply design
- h. Oxygen supply system design
- i. HPA supply piping and valve design up to specified points of connection
- j. Water cooling system design
- k. Controls and instrumentation design
- l. Facility integration design
- m. Performance prediction calculations
- n. Cost and schedule projections for purchasing items
- o. Design Criteria and Requirement Definition
- p. ICDs up to specified points of connection for primary components and subsystems
- q. P&IDs
- r. Component Level SSHA
- s. Integrated CONOPS

- t. FMECA
- u. Maintenance Requirements

The contractor shall complete a CoDR, PDR, and CDR (Section F, Deliverable 37) to maximize communication and ensure that the Government is fully informed during the design process. Preliminary purchasing strategy of long-lead items including YsZ RSH refractory and pressure vessel shall be communicated early in the design process as part of the CoDR, based on Government approval of the CoDR submittal, in order to ensure that the overall project schedule can be achieved. Additionally, the design review process shall include a PDR and a CDR to maximize communication and ensure that the Government is fully informed during the design process. The total BOM for equipment purchasing for the YsZ RSH system shall be presented and reviewed at the YsZ RSH PDR and CDR, as necessary, with purchasing specifications of all RSH system materials and components communicated, as appropriate, during the design review process.

Standardization of facility components between the Project Phoenix Facility and APTU shall be incorporated into the design process to the fullest extent possible. The Project Phoenix Facility must be designed for maximum commonality and standardization with the other AEDC facilities and their supporting infrastructure. Designs shall be compliant with applicable design and engineering industry and AEDC standards.

C.5.4.2 SUBTASK 2 – DEVELOPMENT

The development phase of Block 3 will apply a range of services to include purchasing, fabrication, factory testing, and logistics of all applicable Block 3 system components. The contractor shall develop system components based on approved designs and specifications. The development of such specialized components requires fabrication of materials and equipment from qualified sources. The AL and YsZ RSH refractories shall be fabricated per Government specifications for the heater design. The refractories materials and equipment shall be fabricated by qualified sources only.

The contractor shall identify material and equipment purchasing lead times for all items as a part of the design process. The contractor shall ensure lead times remain up-to-date and are accurately reflected within the project schedule.

All primary components procured as part of this effort shall be pre-tested, where possible, at the vendor facility. The contractor shall perform factory acceptance testing on critical components as required by the Government. The contractor shall schedule and notify the Government of factory acceptance testing at least two weeks in advance to allow Government personnel to attend. Following delivery of the primary components, the contractor shall conduct onsite acceptance testing. The contractor shall schedule and notify the Government of onsite acceptance testing at least one week in advance of onsite accepting testing. The contractor shall provide a final documented inspection report for all acceptance testing performed on components (Section F, Deliverable 38).

The contractor shall perform all logistics functions associated with planning, implementing, and controlling procedures for the efficient and effective transportation, offloading, and storage of components including services and related information from the point of origin to final place of installation.

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The contractor shall identify all equipment warranty information (Section F, Deliverable 47) as required for the equipment purchased.

The contractor shall utilize applicable CLINs for material and equipment purchasing and ancillary services as required in section H.12. Purchasing is subject to Government approval and the purchasing guideline identified in Section H.11 of this TO.

C.5.4.3 SUBTASK 3 – ENGINEERING AND INTEGRATION

The contractor shall perform engineering and integration services as required to install all necessary components of the YsZ RSH System in the AEDC J5 Facility. The integration of components shall follow all specified activities approved in drawings, specifications, and instructions approved by the Government in the final designs.

The contractor shall perform logistics functions and organization of equipment before, during, and after installation activities to include demolition, removal, and disposal of antiquated or unnecessary equipment during the process of installation of equipment or components associated with the completion of this effort. Removal/disposal of equipment shall be conducted in accordance with AEDC policies and procedures.

Ancillary support may be required during the engineering and integration of components. Ancillary support includes such services performed by machinists, boilermakers, welders, pipefitters, and other craft disciplines where an OASIS labor category does not exist (see also section H.12 of the TO).

Prior to installation, the contractor shall confirm the feasibility for integration of systems. If alternate approaches or solutions to integration are identified, the contractor shall communicate the appropriate detail to the Government for consideration and authority to proceed with the alternative.

The contractor shall provide a final report documenting installation details, data collected, as-built and as-installed schematics, and final as-built and as-installed drawings (to include 3D CAD models) (Section F, Deliverable 39).

The contractor shall perform Configuration Management (CM) duties on systems as needed throughout performance of the TO in accordance with standard AEDC protocols and best practices.

C.5.4.4 SUBTASK 4 – VERIFICATION AND TESTING

The contractor shall checkout all system components and subsystems required for operation. The contractor shall verify the system against its primary operation metrics to ensure the overall capability of the test facility can be achieved.

The contractor shall deliver a final report for component-level testing that documents data collected, test data, test data analysis, conclusions, and recommendations (Section F, Deliverable 40). Each report shall be in AEDC TR format and shall be delivered to the Government NLT 30 days after final testing is complete. Upon approval, the Final TR shall have a Distribution Statement D/ITAR and be non-proprietary.

C.5.4.5 SUBTASK 5 – EXIT CRITERIA

This subtask shall include a demonstration test using the J5 Facility to validate the Mach 7.5 operational capability at multiple dynamic pressures. Pressure, temperature, and Mach number shall be measured in the test rhombus using suitable instrumentation to quantify the actual performance of the J5 Facility in its final configuration. Suitable instrumentation for pressure and temperature measurement shall be provided by the contractor and verified for acceptance by the Government. The contractor shall demonstrate simultaneously varying of pressure, temperature, and Mach number over a range from Mach 3.5 to 7.5.

The exit criteria shall address the final delivery of all component systems and subsystems (Section F, Deliverable 41). The contractor shall deliver a final report for the integrated test capability that documents data collected, test data, test data analysis, conclusions, and recommendations (Section F, Deliverable 42). Each report shall be in AEDC TR format and shall be delivered to the Government NLT 60 days after final testing is complete. Upon approval, the Final TR shall have a Distribution Statement D/ITAR and be non-proprietary.

C.5.5 TASK 5 – PROVIDE MAINTENANCE SUPPORT

The contractor shall support maintenance requirements for Project Phoenix systems and subsystems associated with the transition of Project Phoenix into operations. The contractor shall coordinate with Government personnel, third party contractors (e.g., base operating contractor), and other maintenance contractors as required to ensure a successful transition and future operations and maintenance of the facility following completion of the project.

C.5.5.1 SUBTASK 1 – MAINTENANCE TRAINING

The contractor shall be responsible for the generation of final process and procedures and maintenance manuals for the systems and subsystems developed as part of this effort (Section F, Deliverable 43). In addition, the contract shall provide training for future base operating contractors and Government personnel to ensure the facility is maintainable upon project completion (Section F, Deliverable 44). The contractor shall ensure personnel have been adequately trained in the operations and maintenance of the facility and its systems and subsystem components.

C.5.5.2 SUBTASK 2 – COMPONENT SPARES

The contractor shall ensure provision of adequate facility spares are integrated into the development process of the project. Adequate system spares for critical components shall be procured enabling up to two years of aggressive test operations. In addition, refractory spares shall be procured to allow seven years of aggressive operation before a limited replacement of refractory is required (Section F, Deliverable 45).

The contractor shall purchase adequate spares for instrumentation items to avert emergency down time in the event of component failure during testing. The contractor shall deliver initial spares for critical long lead components with a list of suppliers identified.

C.5.5.3 SUBTASK 3 – ASSET SUSTAINABILITY AND OPERATION

The contractor shall ensure asset sustainability is an integral part of the development process. Project Phoenix system components shall be designed so that normal operations will not exceed

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predetermined facility safety limits. The contractor shall ensure system design and performance minimize stress on components, maximize the life expectancy of refractory, pumps, motors, instrumentation, etc., and results in an overall system reliability improvement.

The contractor shall locate sensitive equipment in areas environmentally sealed or controlled, reducing the effect of contaminants and humidity on components, increasing operational availability, and reducing downtime due to maintenance.

The contractor shall develop operating instructions for components and integrated facility operations, maintenance plans, creation and update of work instructions, hazard analyses for systems and subsystems, asset CM, instrumentation calibration requirements, equipment warranties, and system health tracking plans (Section F, Deliverables 43, 46, and 47).

C.5.5.4 SUBTASK 4 – OUTAGES

The contractor shall coordinate all required utility outages with the Government and provide written notice at least one month in advance at a minimum. The contractor shall ensure the outage is coordinated with AEDC personnel and on the AEDC Outage Schedule. Upon permission to perform the outage, the contractor will be provided a window in which to complete the outage. Once the work is completed, the Government shall be notified to communicate completion by the AEDC Outage Scheduling group